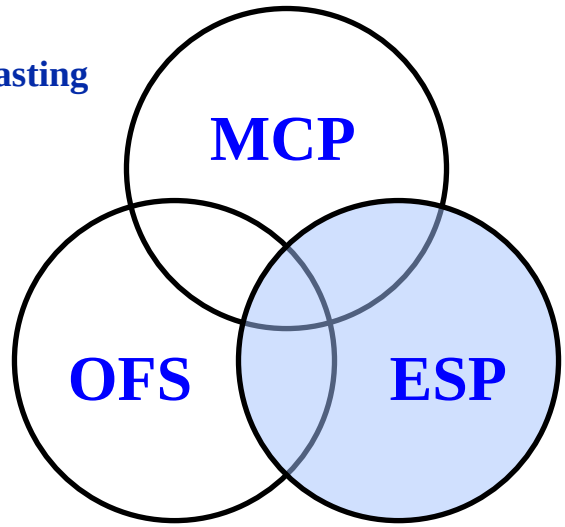
NWSRFS
Ensemble Streamflow Prediction

- Manual Calibration Program (MCP)
- Operational Forecast System (OFS)
- **Ensemble Streamflow Prediction (ESP)**

NWS Workshop on Hydrologic Forecasting
Prague Campus
Czech University of Agriculture
June 20-24, 2005



Ensemble Streamflow Prediction

- NWSRFS models and current states.
- Historical MAPs and MATs from calibration.
- Flexible analysis window.
- Many forecast variables.
- Better performance under extreme conditions.
- Use of weather and climate forecasts.

ESP Uses

- Long range seasonal water supply.
- Spring snowmelt volume forecasts.
- Spring snowmelt peaks.
- Minimum flows for navigation, irrigation, environmental, recreation, etc.
- Experimental Short Term Ensembles

  Hours to days

ESP Flexibility

- Time Window
  - Days, Weeks, Months, Seasons
- Variables
  - Volume
  - Mean Discharge
  - Peak Flow
  - Low Flow
  - Days to Peak, Low, or Specified Rate

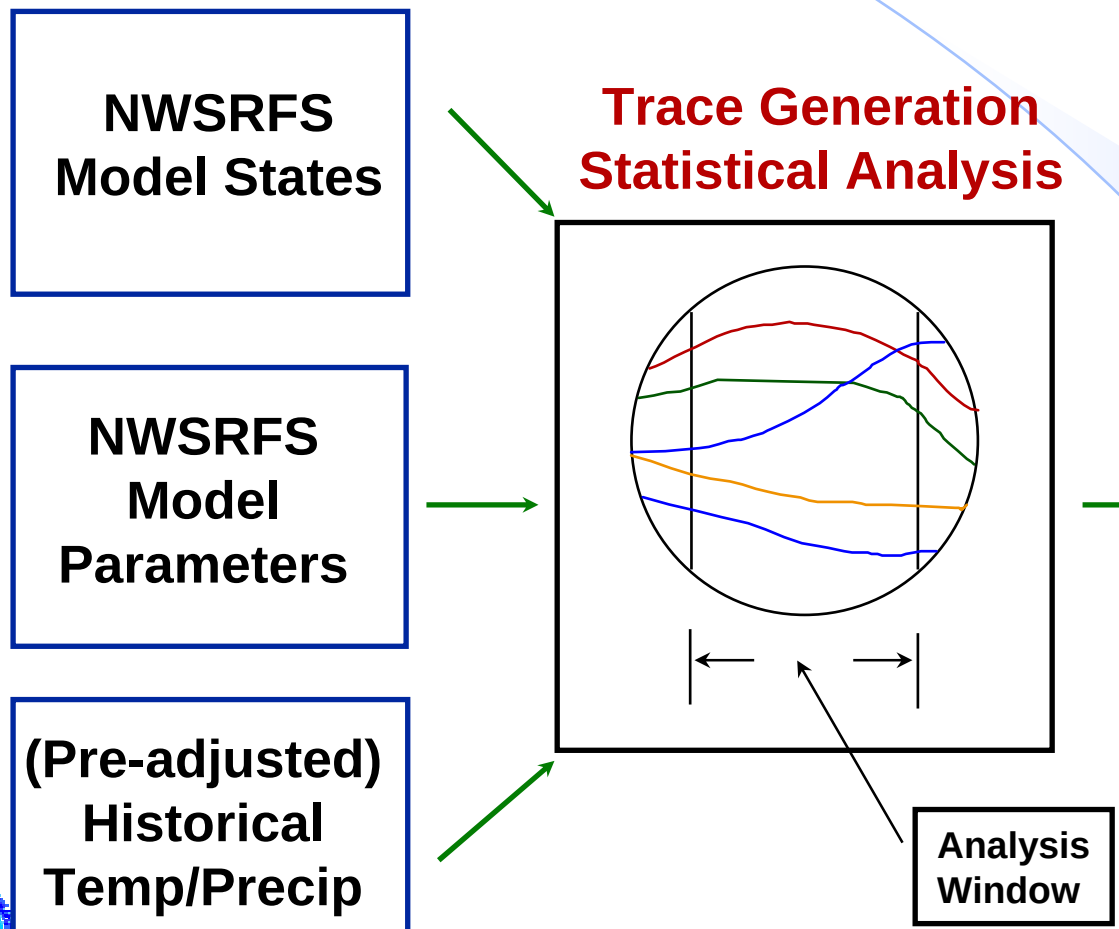
Key Model States
Initial Conditions Are Important

- Snow Model
  - Liquid and frozen water equivalent
  - Heat content
  - Areal extent
- Soils Model
  - Upper zone moisture content (tension/free)
  - Lower zone moisture content (tension/free)
  - Frozen ground

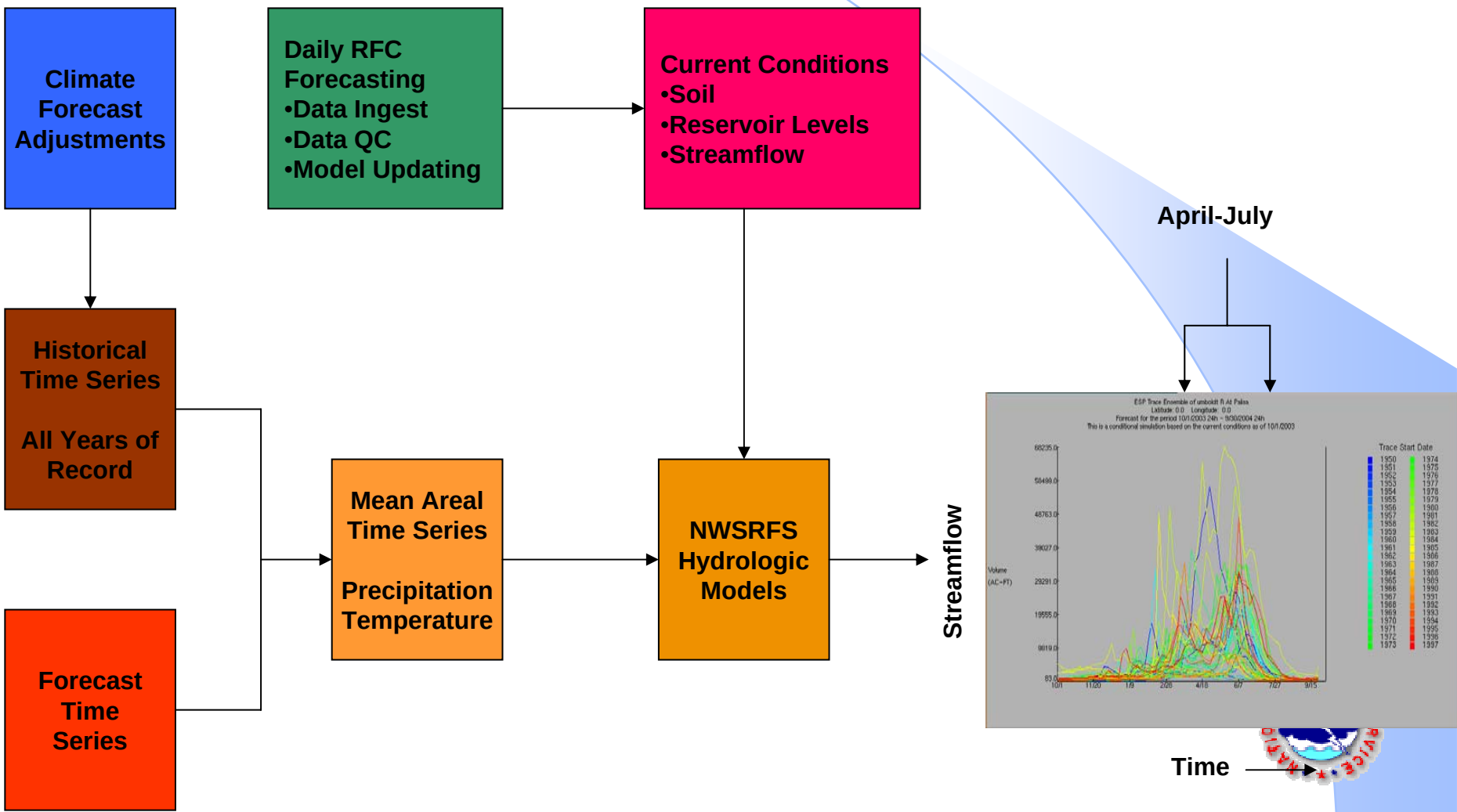
Accurate Snowpack States

- Real time network consistent with calibration network.
- Quality control temperature and precipitation observations.
- Update snow water equivalent with snow course observations.

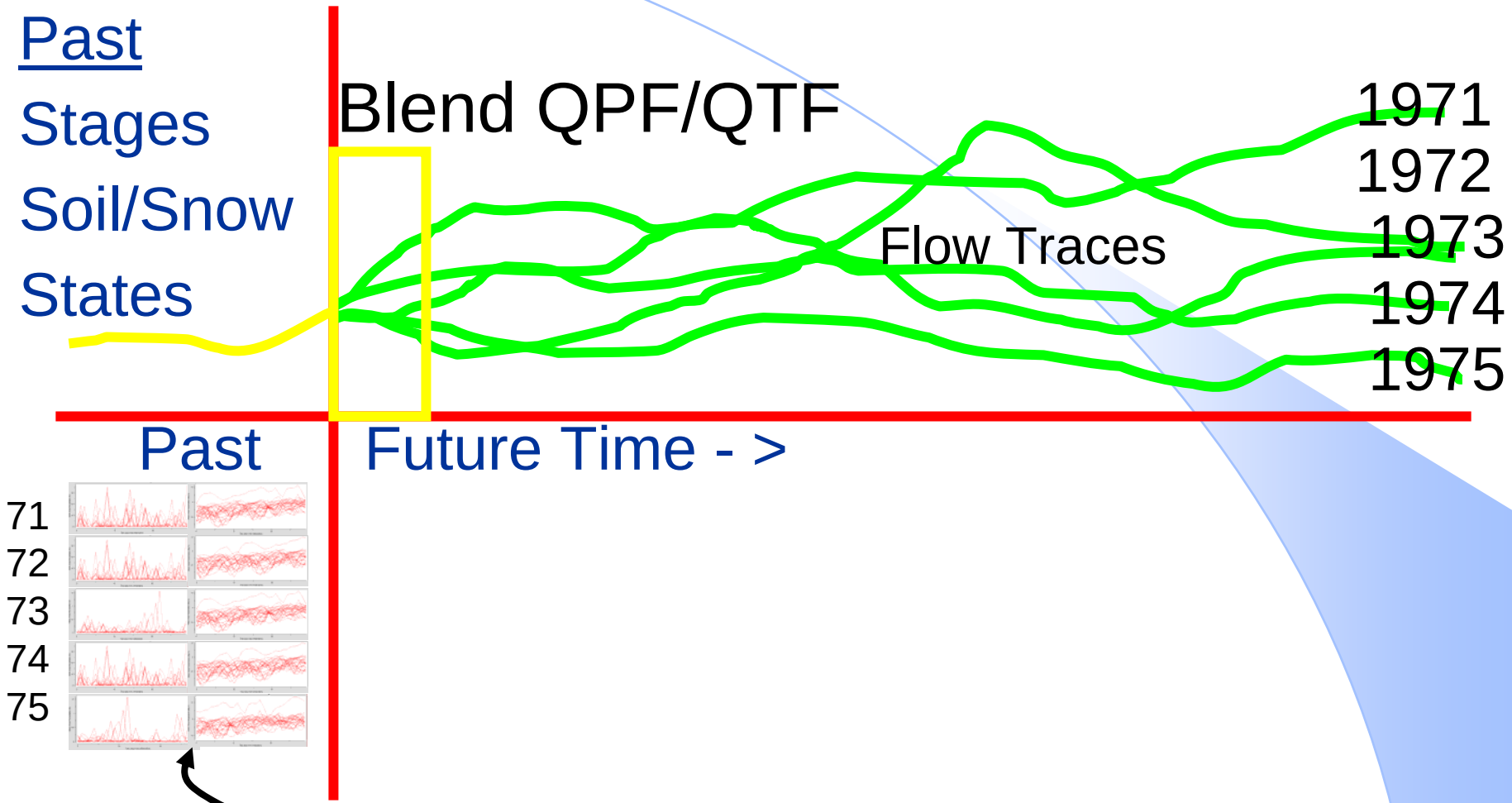
ESP Process


NWSRFS
Model States
NWSRFS
Model
Parameters
(Pre-adjusted)
Historical
Temp/Precip
Trace Generation
Statistical Analysis
Analysis
Window
Probablistic
Forecast

Ensemble Streamflow Prediction



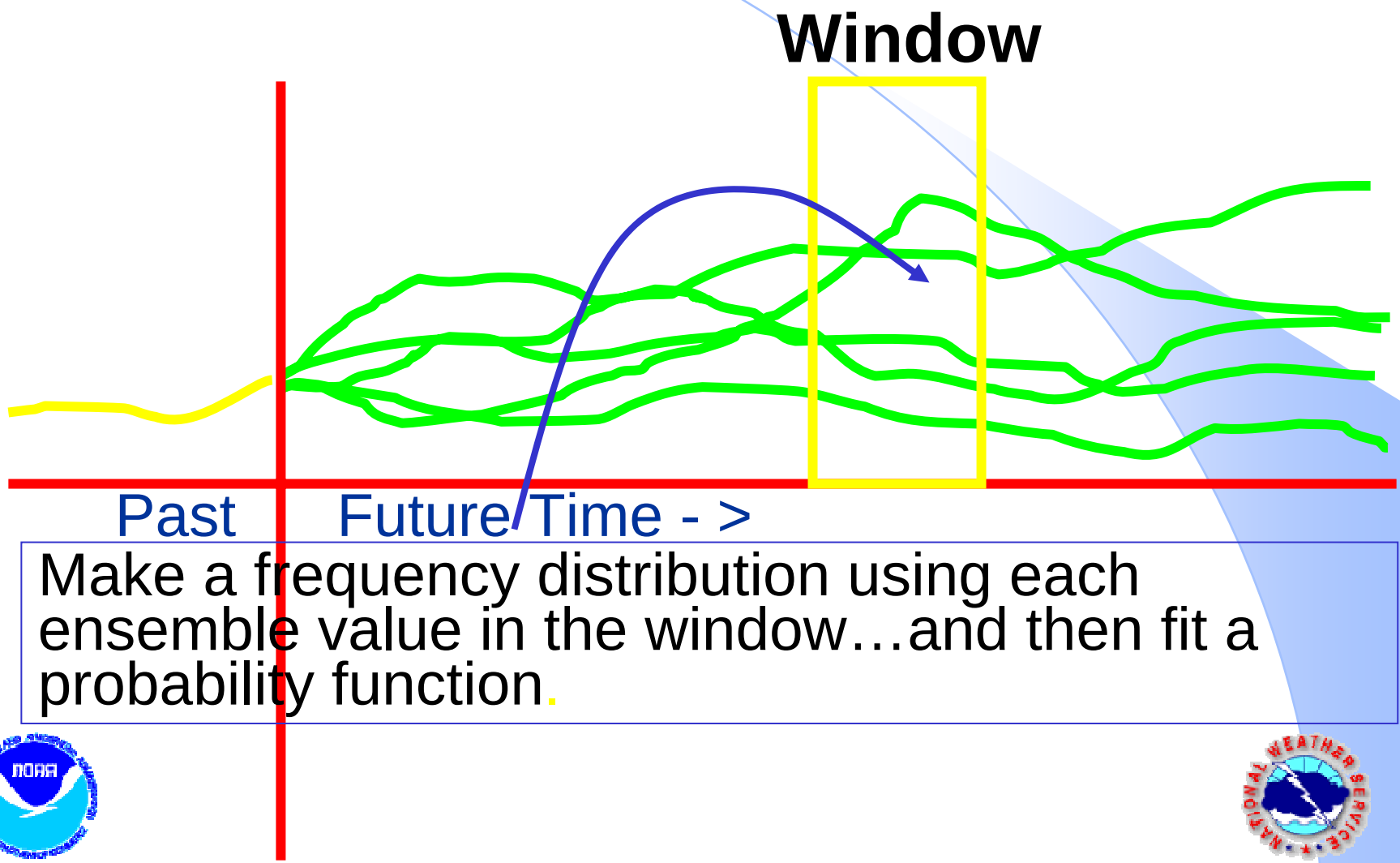
Making an Ensemble Forecast Using ESP



Historical Precip/Temps for Past Years

Creates a Flow for Each Year

Defining Your Time For the Forecast

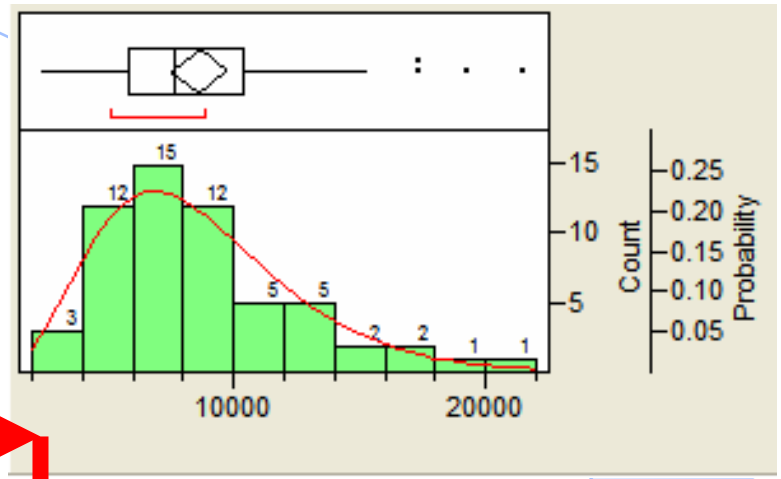


Make a frequency distribution using each ensemble value in the window…and then fit a probability function.

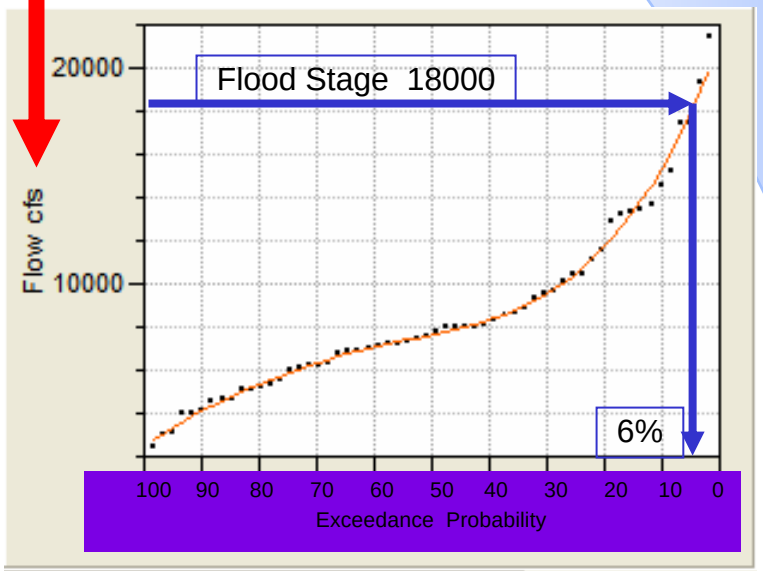
Elementary Probability Concept

21500	8690	6240
19300	8600	6200
17400	8350	6100
17400	8110	5960
15200	8040	5590
14600	8040	5300
13700	8040	5250
13500	8040	5150
13300	7780	5140
13200	7600	4710
12900	7420	4680
11600	7380	4570
11100	7190	4110
10400	7190	4010
10400	7130	4010
10100	6970	3100
9640	6930	2990
9560	6870	2410
9310	6750	
8850	6350	

Window

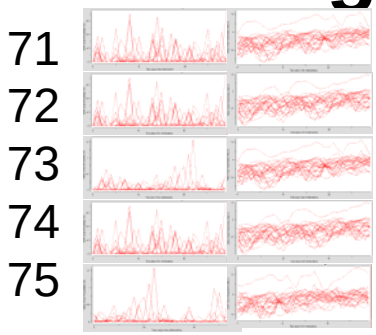


(PDF)

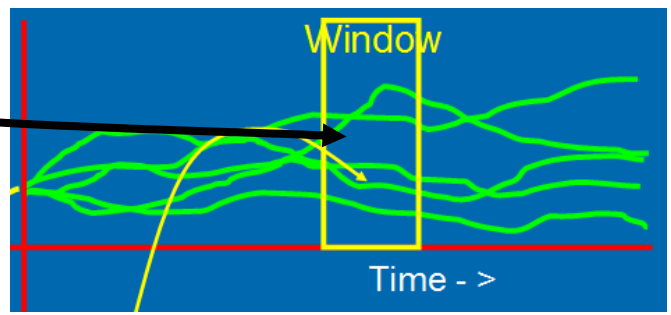


Climate Variability In ESP

Pre -Adjustment Technique
Weight/Modify on Input Side



Post -Adjustment Technique
Weight On Output Side



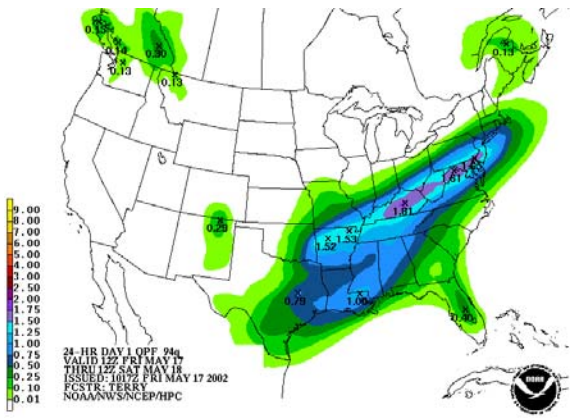
ESP Use of Weather and ClimateForecasts

Historical MAT and MAP

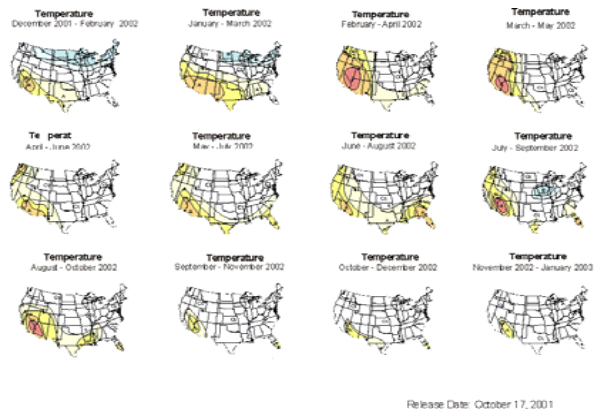
Adjustment System

Adjusted Historical MAP and MAT

Weather Forecasts



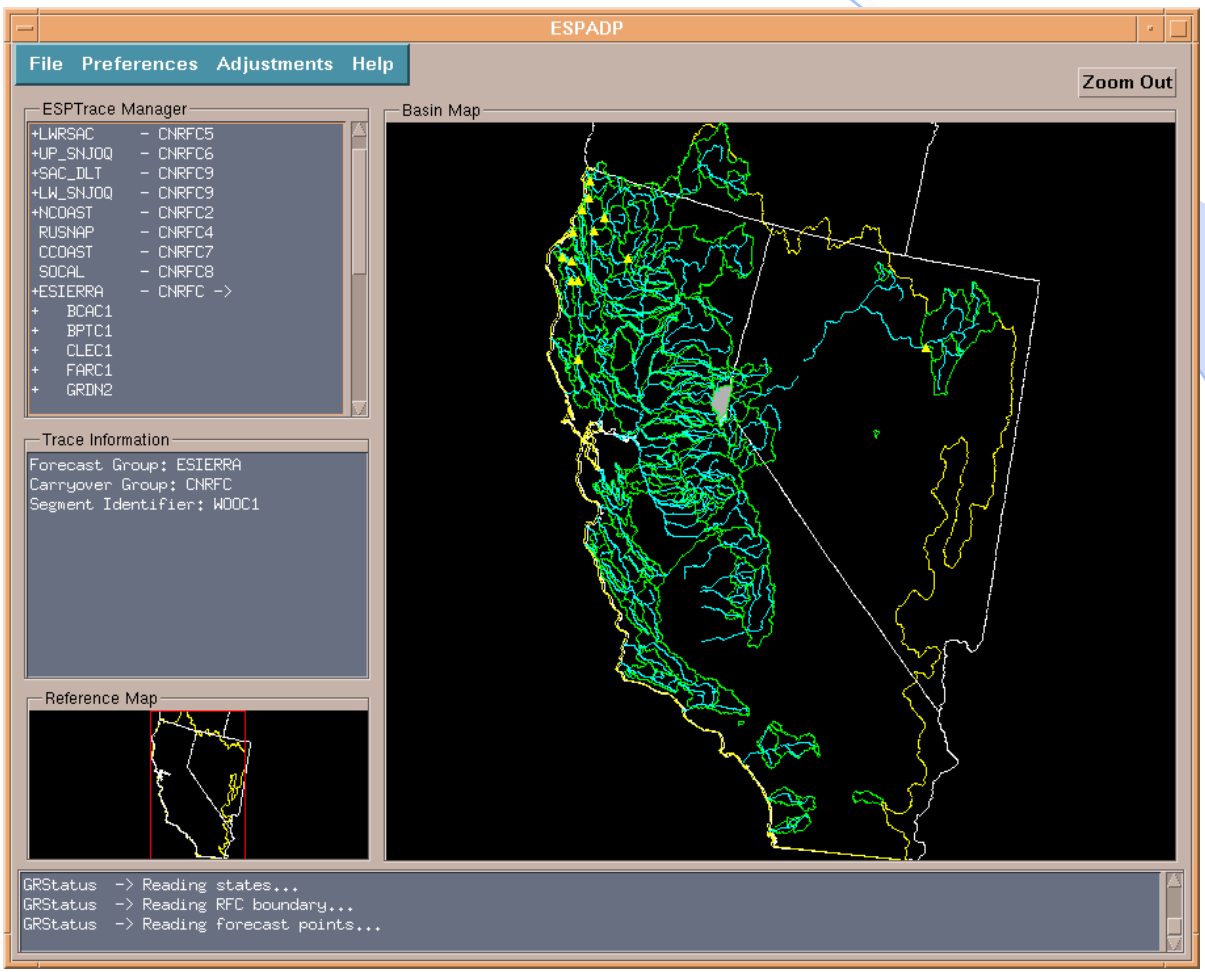
Climate Forecasts



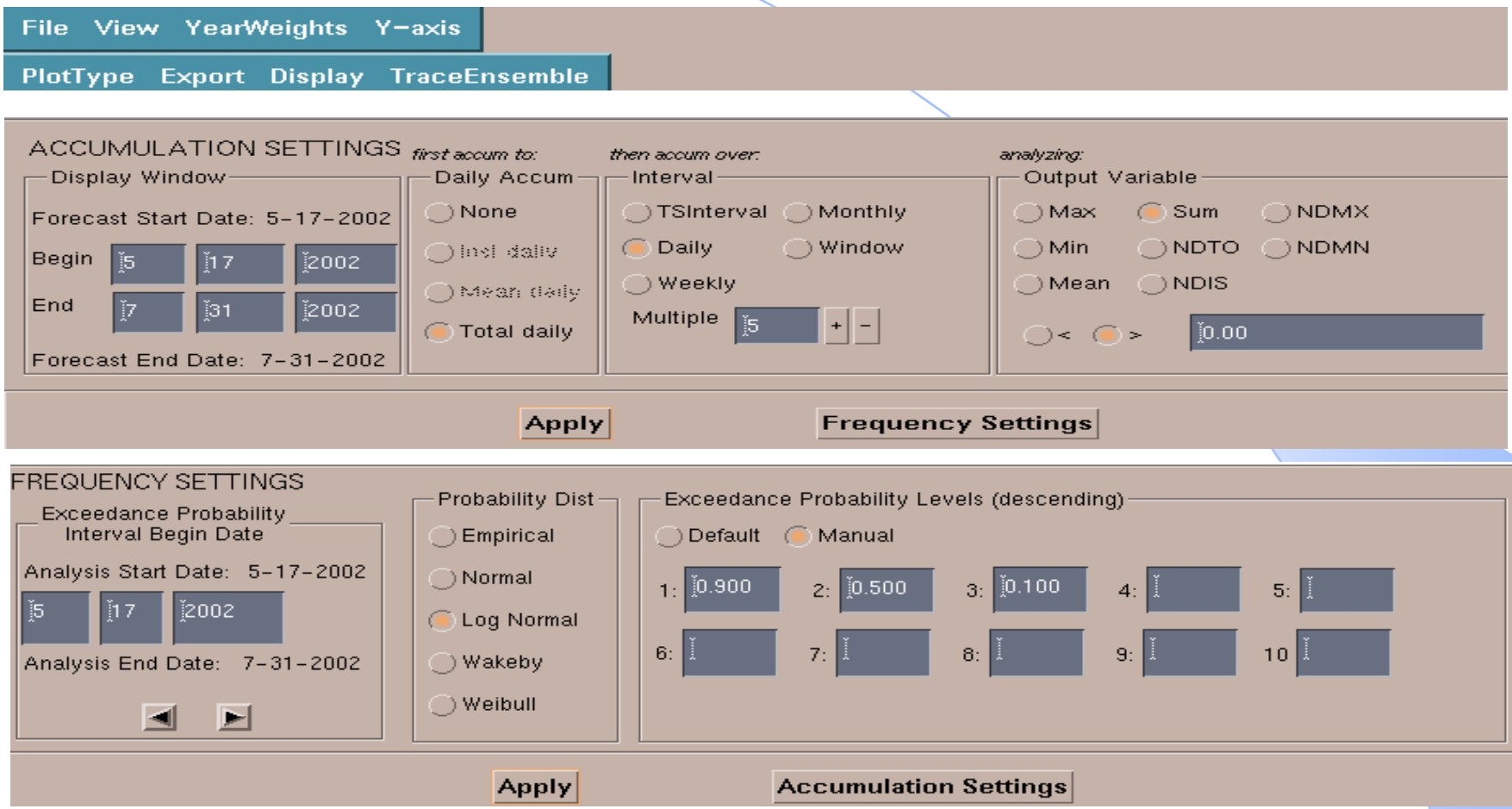
ESP Product Generation

- Generate conditional traces with ESP
- Select product attributes and generate tables and graphics with ESP Analysis and Display Program (ESPADP).

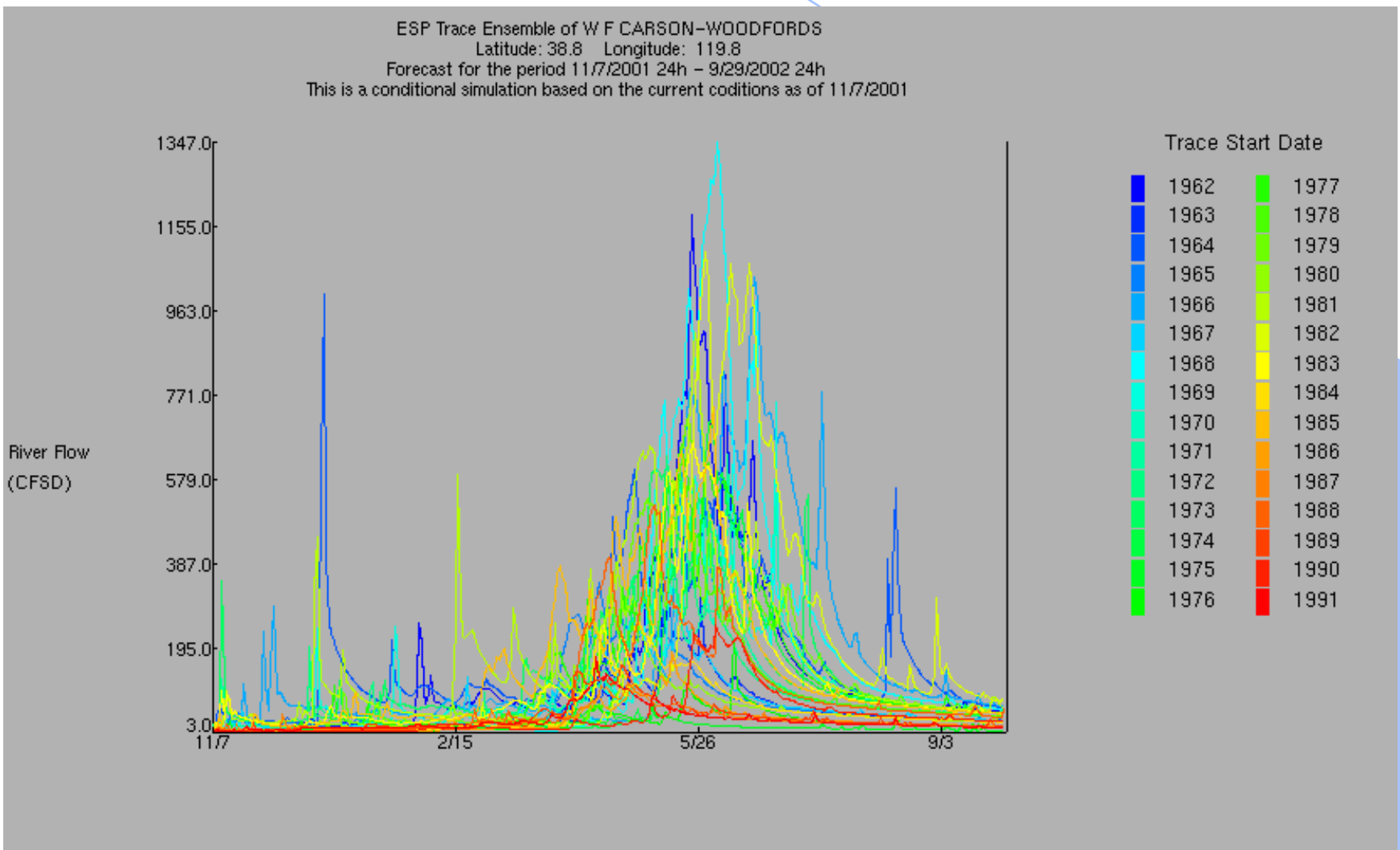
ESPADP - ESP Analysis and Display Program



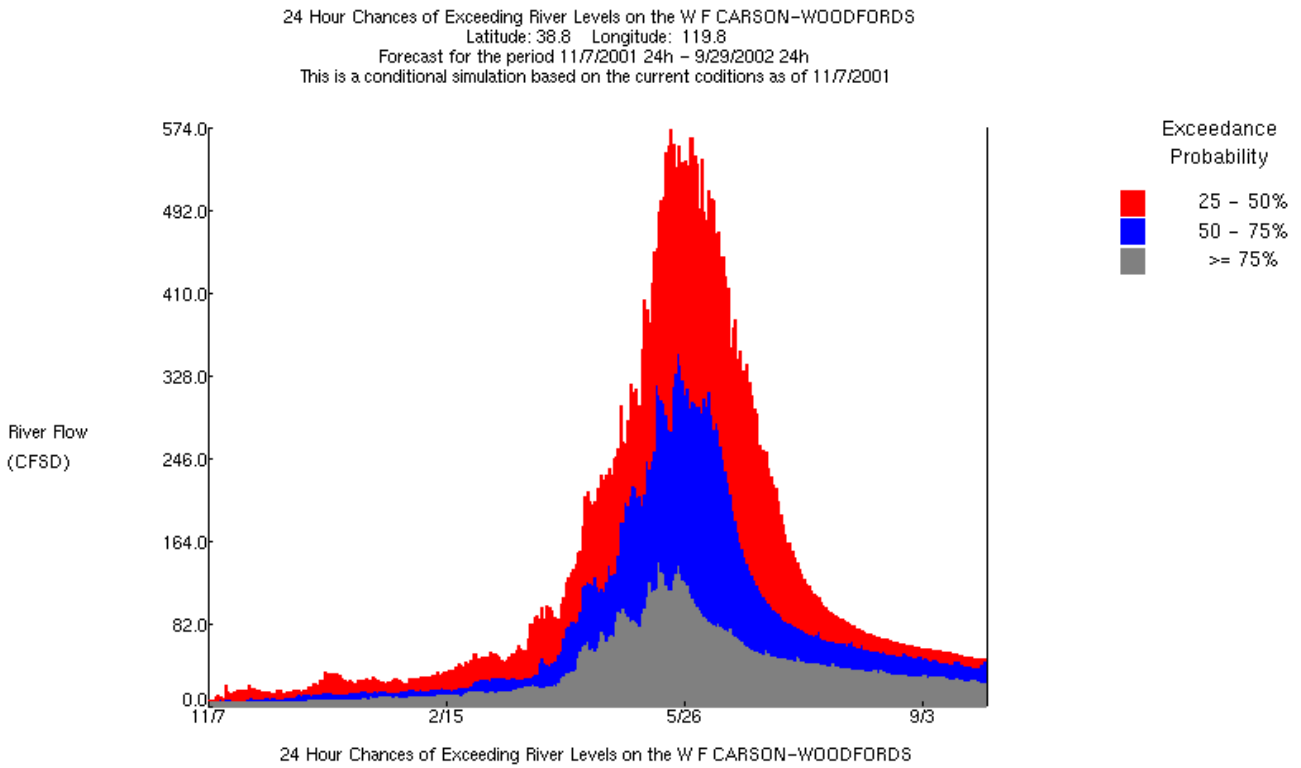
ESPADP Options



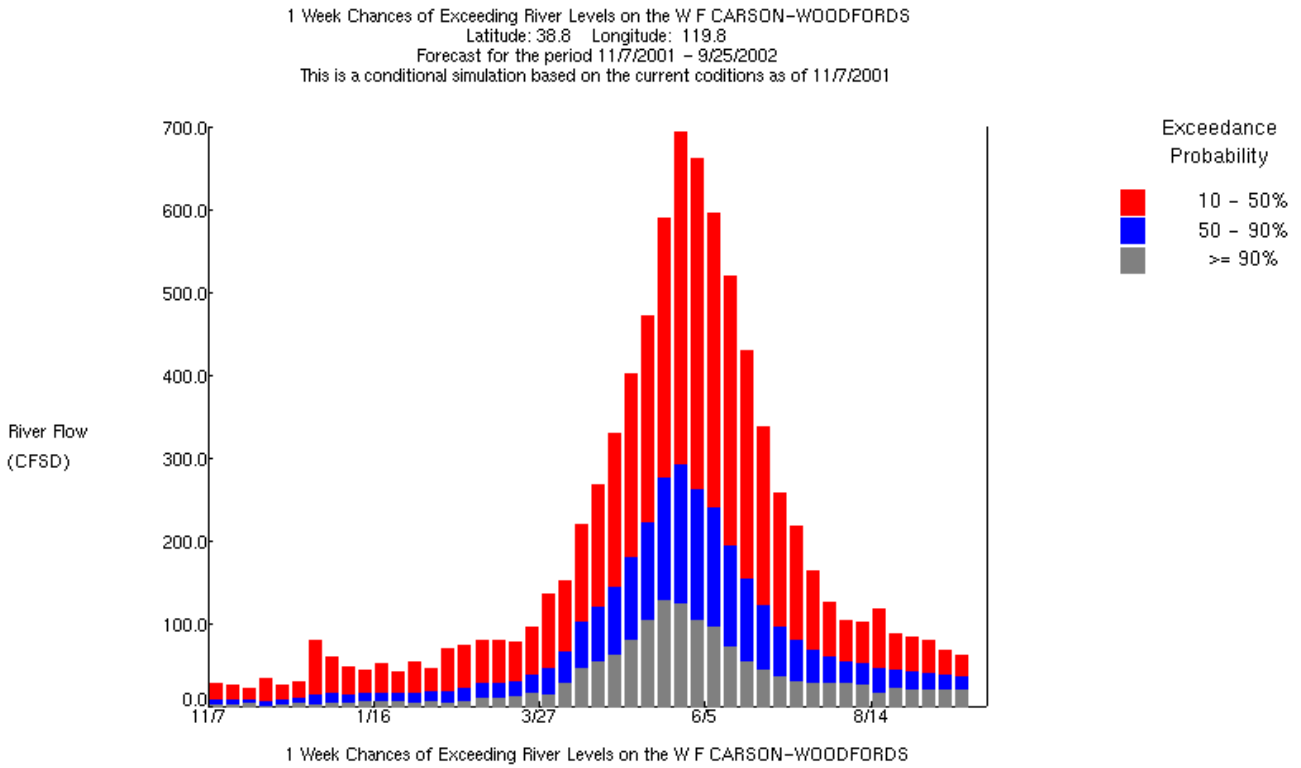
ESP Trace Ensembles



Mean Daily Flows

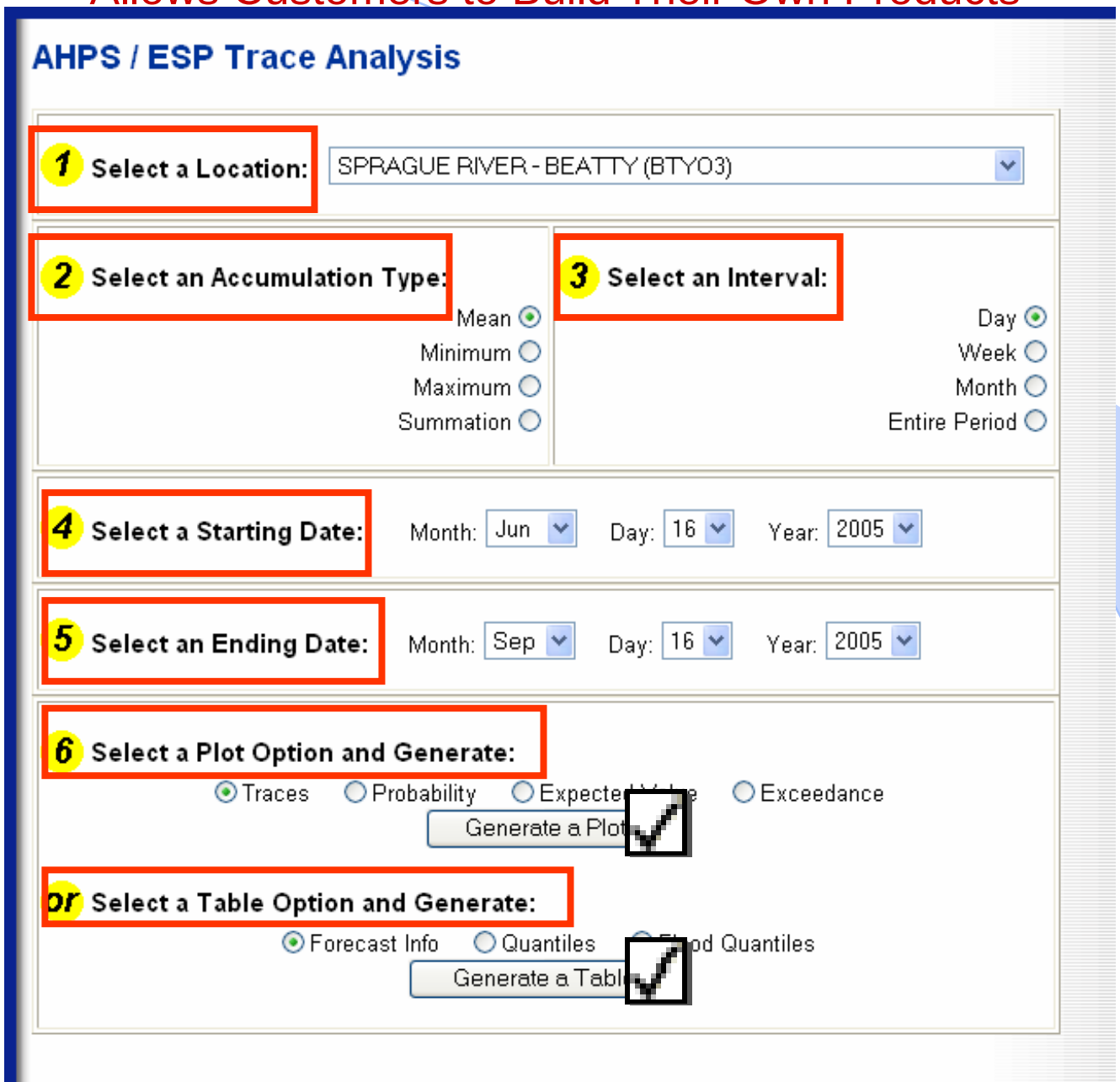


Mean Weekly Flows



ESPADP Web Interface

"Allows Customers to Build Their Own Products"

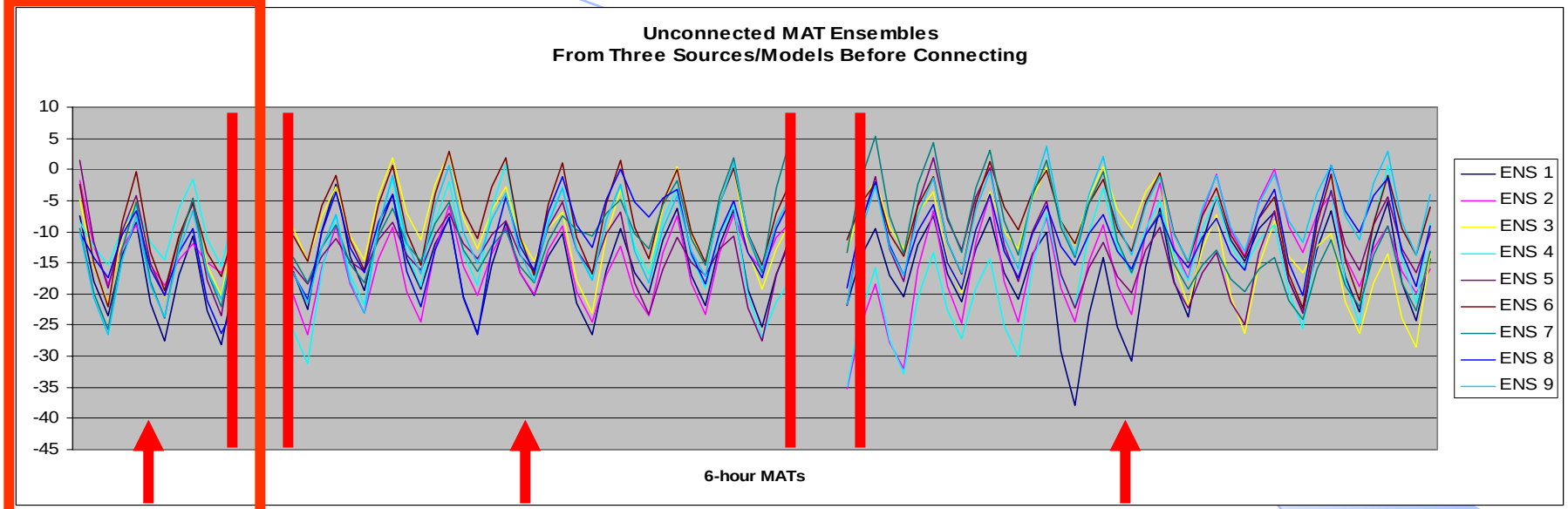


Suggestions for Using ESP

- Data quality control is a high priority.
- Be aware of biases or limitations in the model calibration.
- Avoid large changes to model states that cannot be explained by input data errors.
- Remember that ESP does not use runtime MODs.

Future use of ESP

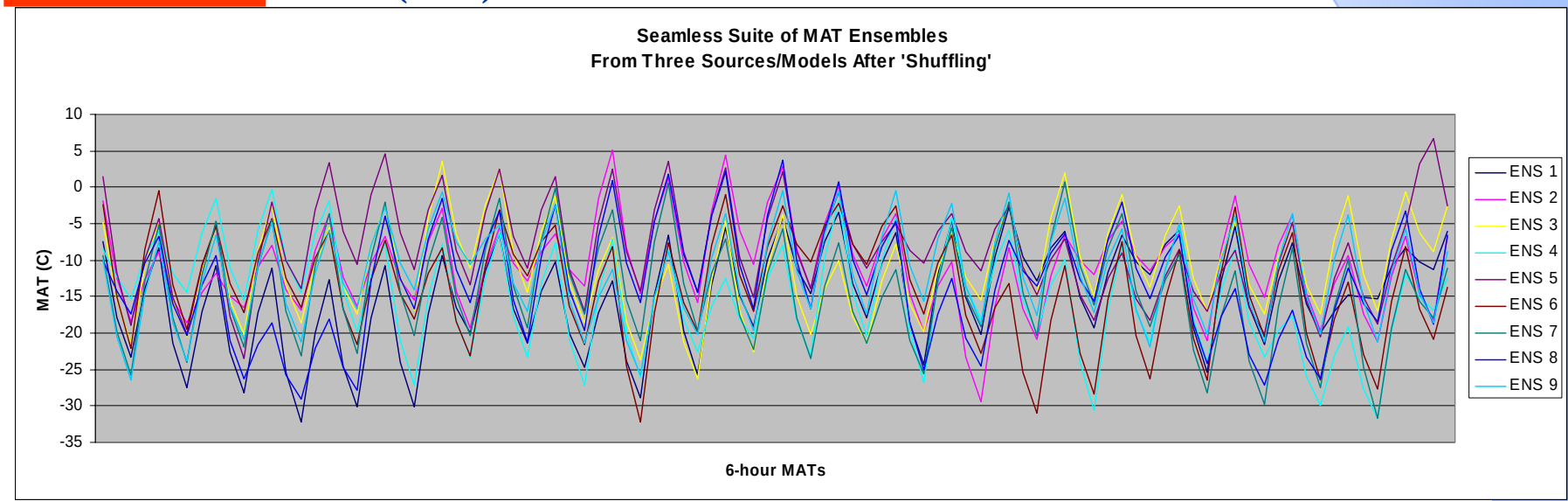
- Better use of weather/climate forecasts.
- Implementation of error models.
- Development of short-term techniques.
- Development of regulated forecasts.
  - Reservoir and diversion impacts.
- Interactive use by customers/partners.



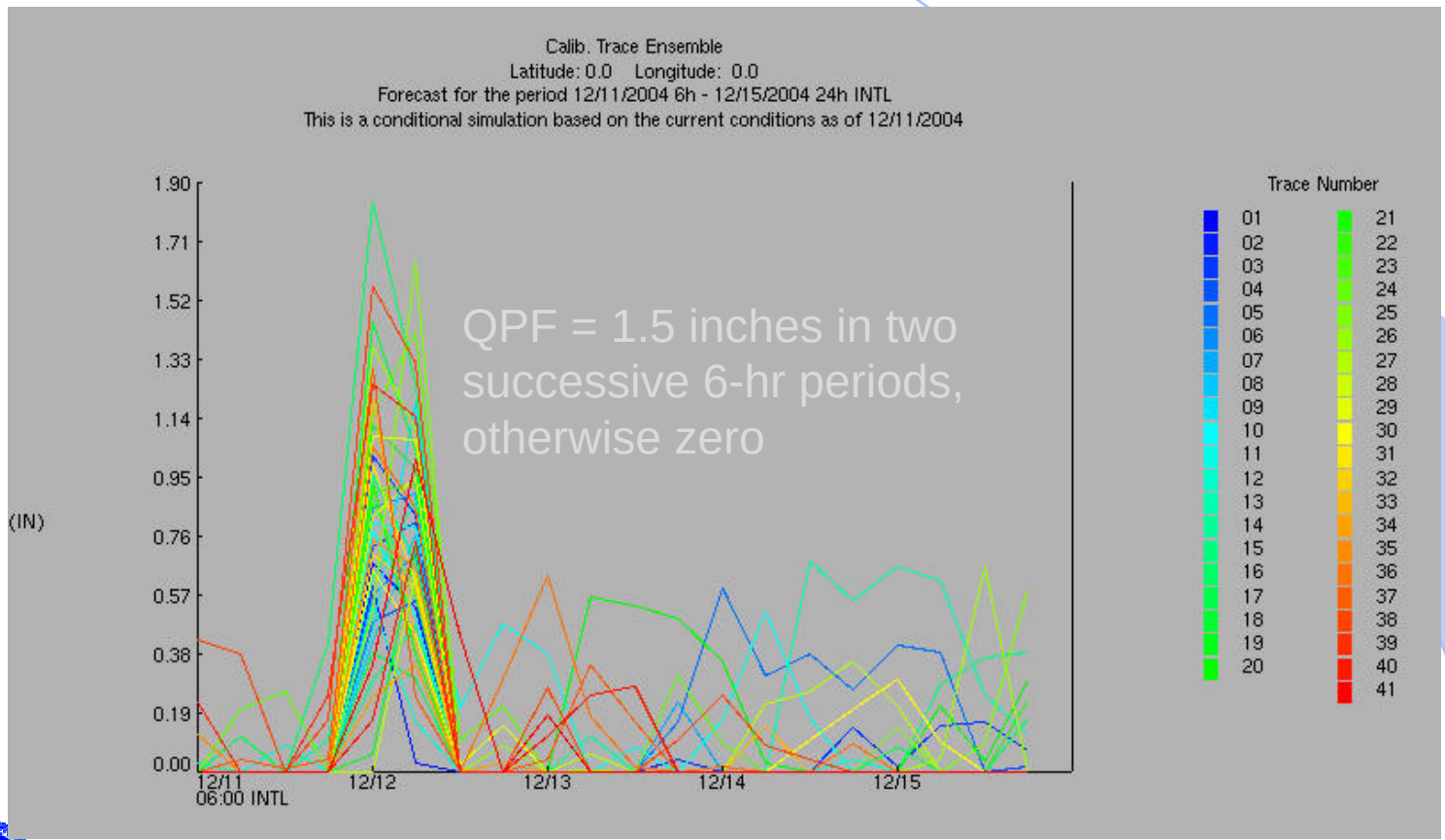
SHORT TERM DAY 1-3 HAS

MEDIUM RANGE DAY 4-14 GFS(MRF)

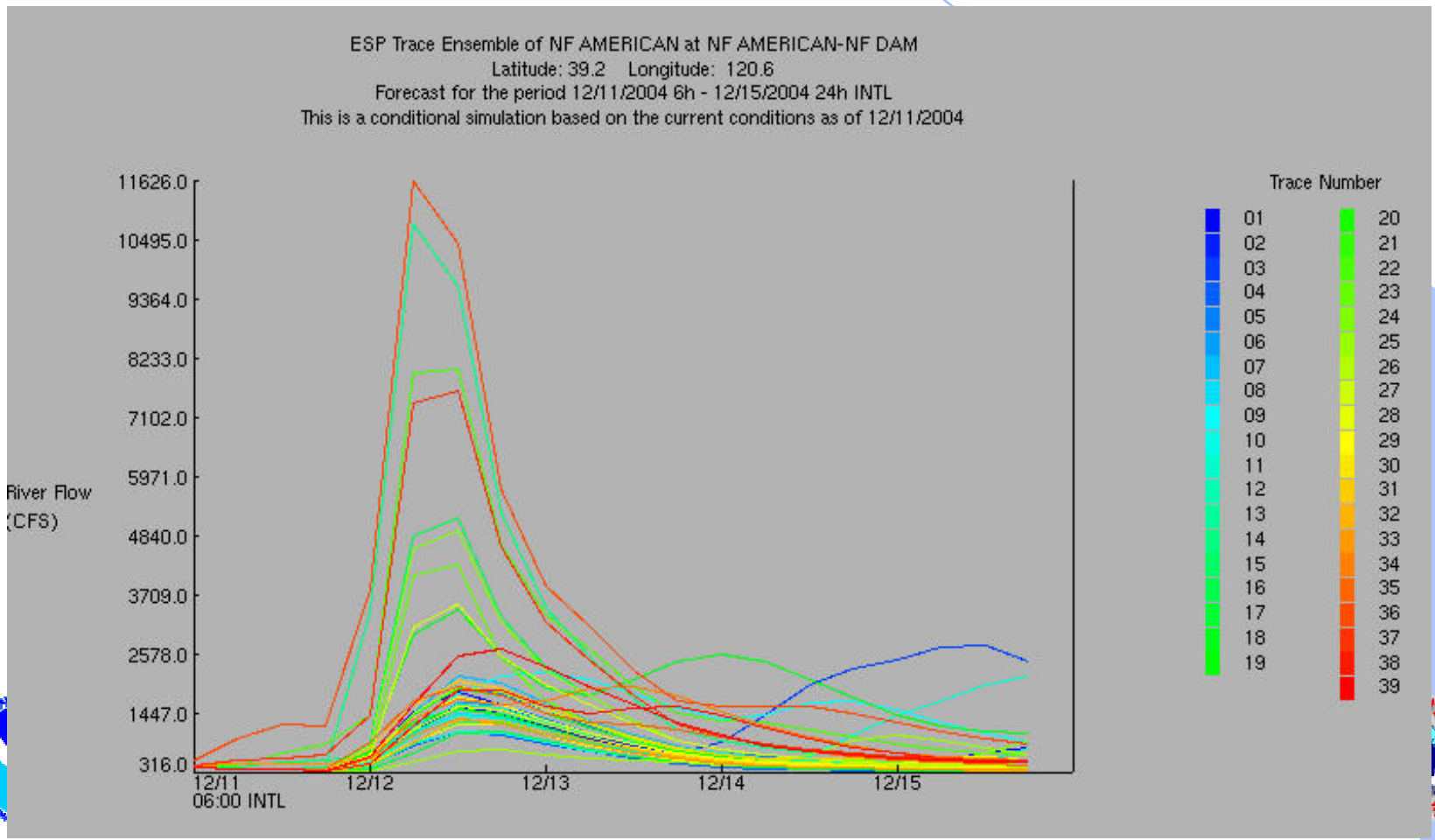
LONG RANGE DAY 15 – 365 CPC PRE-ADJUSTMENT/ OTHER



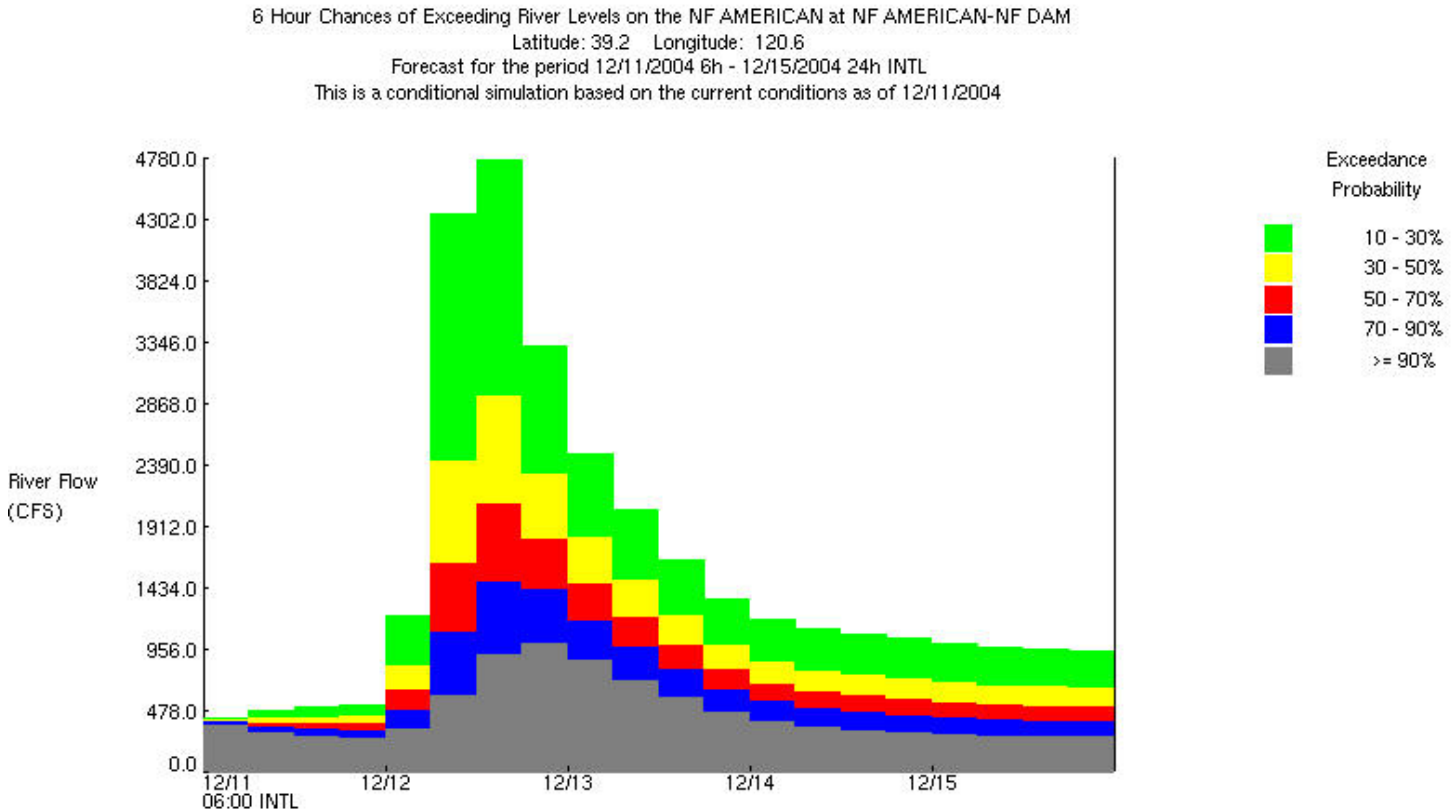
Short Term
5-day Precipitation Ensembles



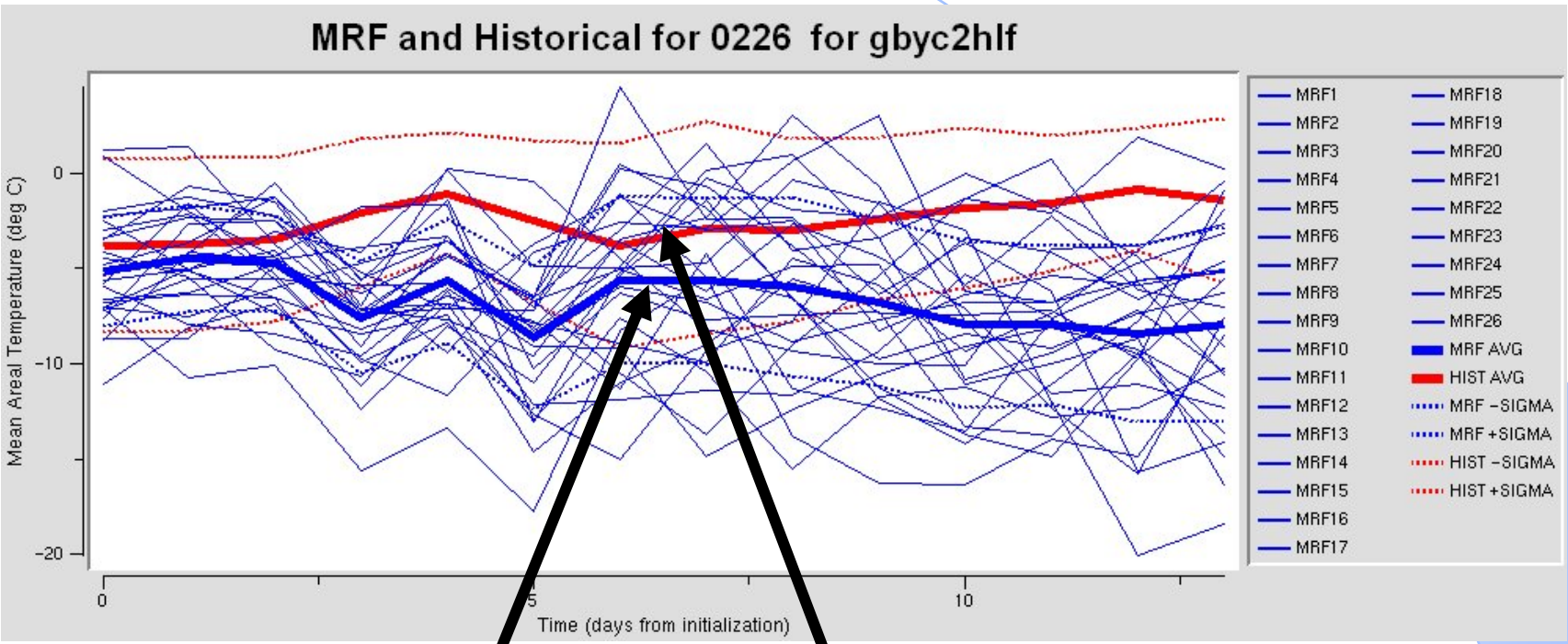
Short Term
5-day Streamflow Ensembles



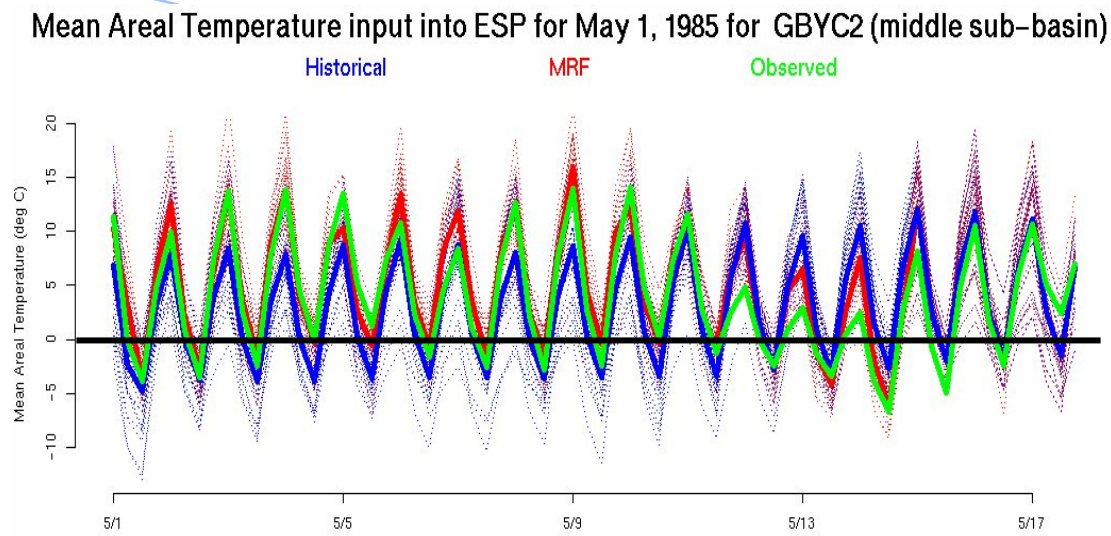
Short Term
5-day Streamflow Forecast Distribution

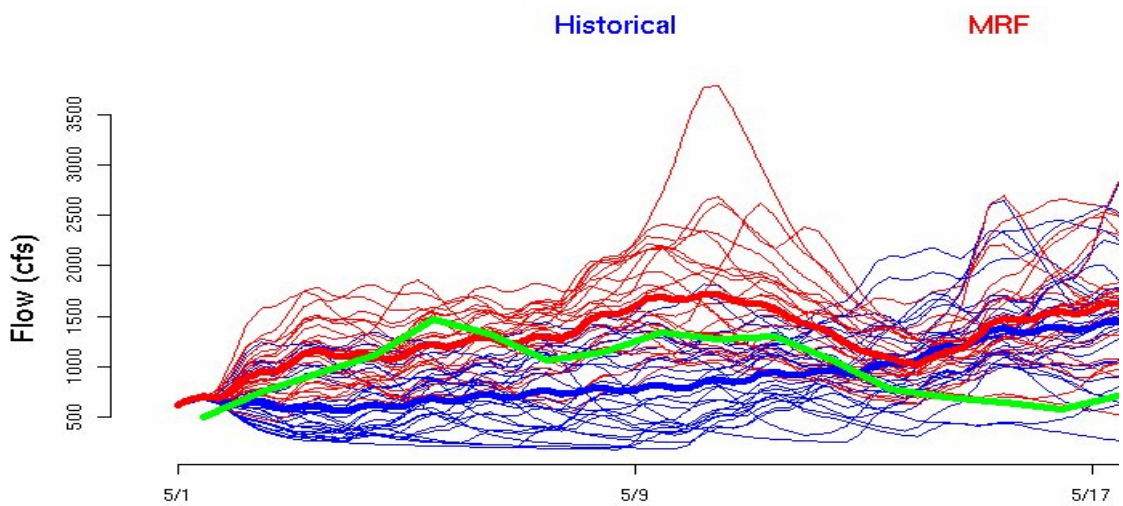


Medium Range Forecasts

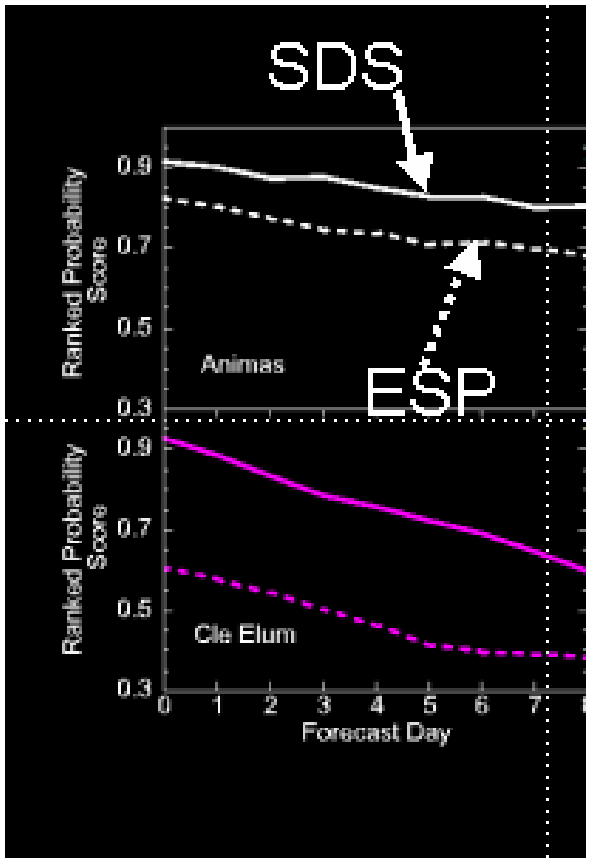


MRF is colder than normal in this case.





Hourly instantaneous flow ensembles are created by ESP and saved. MRF shows higher flows than historical when it is warmer (during the first week). These may be converted into probabilistic forecasts…



An example of the skill in producing streamflow runoff from using temperatur and precipitation downscaled from the MRF vs historical precipitation and temperature (ESP).

It shows by using temperatures from the downscaled MRF in lieu of historical information that streamflow forecasts can be improved.

The End

Ensemble Streamflow Prediction Component (ESP)